PO-0720

Fiducial based image guided-intensity modulated radiotherapy (IG-IMRT) in high risk prostate cancer.

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Purpose/Objective: High dose image guided radiotherapy (IGRT) using prostate fiducials is standard of care for low and intermediate risk patients. However, high risk patients also benefit from prophylactic intensity modulated radiotherapy (IMRT) to the lymph nodes. The prostate can move independently to the pelvic nodes, therefore the safety of combining fiducial IGRT and pelvic nodal IMRT in high risk patients is uncertain. We aim to ascertain the dosimetric impact of employing fiducial-based hybrid IG-IMRT on the lymph node planning target volume (PTV).
Materials and Methods: Thirty consecutive IMRT prostate and pelvic lymph node dosimetric plans were retrospectively reviewed after recalculation with incremental 1mm isocentre movements in all directions up to 10mm. In our centre, all IGRT images and shifts are recorded creating a population based database. Combining this database and the dosimetric data we calculated the overall risk of failing to maintain the following lymph node PTV statistics with fiducial IG-IMRT:
- PTV receiving > 99% of target dose (V99%) > 90%,
- PTV receiving > 95% of target dose (V95%) > 95%
- PTV receiving > 50% of target dose (V50%) > 100%.
Results: Shifts in the left, right, and anterior directions do not have a significant impact on dose delivery with less than 0.25% risk of PTV coverage failure. Shifts posteriorly have the largest impact on dose but this still has less than 1% risk of failing PTV coverage.
Conclusions: The risk of failing lymph node PTV coverage is very low with IG-IMRT and therefore we recommend adopting IG-IMRT in high risk prostate cancer patients receiving prophylactic lymph node irradiation. This will allow a reduction in CTV to PTV margins to the prostate volume leading to reduced toxicity and scope for dose escalation.

PO-0721

Hypofractionated stereotactic body radiation therapy in localized prostate cancer

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Purpose/Objective: Technological advanced in stereotactic body radiation therapy have allowed precise targeting and delivery of radiation to the prostate while sparing normal tissues. This is suitable device for performing hypofractionated stereotactic body radiotherapy. We report our experience using cyberknife to patients with localized prostate cancer.
Materials and Methods: This study was based on a retrospective analysis of the 65 patients treated with CyberKnife radiotherapy for localized prostate cancer. Image-guided SBRT was delivered to all patients using the CyberKnife (Accuray Inc., Sunnyvale, CA) with motion tracking of internal fiducial seeds. Thirty-five patients identified as low and favorable intermediate risk group received irradiation at a dose of 36.25 Gy in 5 fractions of 7.25 Gy per fraction. Thirty-two unfavorable intermediate and high risk group patients received 45 Gy at whole pelvis by three dimensional radiation therapy or intensity modulated radiation therapy and received a boost by the CyberKnife at dose of 21 Gy in 3 fractions. The acute and late toxicities were recorded using the Radiation Therapy Oncology Group scale and the CTCAE, version 4.0. Prostate-specific antigen response was monitored.
Results: All 65 patients finished planed radiation therapy without any severe complication. The median follow-up for patients was 36 months (range 6 - 56 months). There were two biochemical failures in high risk patient who received whole pelvis radiation therapy and cyberknife boost. Acute Grade 1 and Grade 2 gastrointestinal (GI) toxicities were observed in 38.5% and 3.1% of the patients, respectively. There were no acute Grade 3 or 4 GI toxicities. Late Grade 3 GI toxicity, rectal bleeding, was noted in 2 patient in high risk group (3.1%) but bleeding was stopped with 3 times laser coagulation in one patients. Acute Grade 1 and Grade 2 genitourinary (GU) toxicities were seen in 43.1% and 21.5%of the patients, respectively. There was acute Grade 3 urinary frequency in one patients of high risk group.
Conclusions: Our results showed favorable biochemical response and low toxicity for hypofractionated stereotactic body radiotherapy with CyberKnife for localized prostate cancer. However, more follow up with a larger cohort is required to confirm durable biochemical control rates and late toxicity profiles.

PO-0722

Planning target volume margins in image-guided radiotherapy for prostate cancer

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Purpose/Objective: To determine the optimal planning target volume (PTV) margins in image-guided radiotherapy (IGRT) for prostate cancer, intra-fraction prostate motion was examined.
Materials and Methods: During 32 fractions of Cyberknife treatment, prostate motion as tracked by the stereoscopic X-ray images of the implanted fiducials was examined. The CyberKnife uses a stereoscopic X-ray system to obtain the position of the prostate target through the monitoring of implanted fiducial markers. If there is a significant deviation, the treatment is paused while the patient is repositioned by moving the couch. The deviations calculated from X-ray images acquired within the time interval between two consecutive couch motions constitute a data set.
Results: The averages of intra-fractional motion of fiducial markers were 1.1 mm for cranio-caudal, 0.3 mm for left-right, and 1.2 mm for antero-posterior. The maximum of intra-fractional motion of fiducial markers were 7.9 mm for cranio-caudal, 2.1 mm for left-right, and 11.5 mm for antero-posterior. Intra-fractional fiducial marker motion of 5.0 mm or greater was observed only in two fractions among 32 fractions. In addition, incidence of intra-fractional fiducial marker motion of 3.0 mm or greater increased with time in cranio-caudal and antero-posterior.
Conclusions: Although PTV margins of 10 mm or greater is necessary to completely cover the intra-fractional prostate motion, PTV margins of 5 mm were adequate to cover the cranio-caudal and antero-posterior intra-fractional prostate motion in more than 90% of fractions. PTV margins of left-right seemed to be able to reduce to 3 mm. Reduction of treatment time is needed to reduce the PTV margins in IGRT of prostate cancer.

PO-0723

Stability of dose to the rectum during salvage radiotherapy with endorectal balloon after prostatectomy

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Purpose/Objective: To investigate the spatial and temporal variability of the endorectal balloon (ERB) position in the setting of postoperative radiotherapy and to investigate the impact of ERB variability on the dose delivered to the rectal wall (R_{wall}).
Materials and Methods: For 7 patients with biochemical recurrence after prostatectomy and referred for salvage radiotherapy of the prostate bed, a daily-inserted air-filled (50ml) ERB was applied and a VMAT planning technique was used. The prescription dose was 66Gy (2Gy/fraction). During treatment, weekly control CTs were acquired and translational matches to the reference CT by means of surrounding pelvic bones (symphysis etc.) were performed. Rectum, rectum balloon and rectal wall structures were contoured and the original treatment plan was calculated on the control CT. The relative volumes of R_{wall} exposed to doses ≥ 40Gy (V_{40}), ≥ 60Gy(V_{60}), ≥ 65Gy(V_{65}) were calculated. Additionally, the balloon shifts (changes in distance from the rectum balloon center to the isocenter) were measured. The dose volumes and balloon shifts were plotted against the time (number of days between the respective control CT and the planning CT). Significance tests were made for each patient for detecting systematic changes over treatment time.
Results: The figure shows a graph of the balloon shifts for each patient over time. R^2 statistics and p values were calculated to check if the observed trend that the balloon shifts away from the isocenter over time was significant. Significance was found only in one patient.